

Claims

1. A molecular single electron transistor (MSET) detector device comprising at least one organic molecule attached to a drain electrode and a source electrode wherein, in use, said at least one organic molecule provides a quantum confinement region characterised in that at least one analyte receptor site is provided in the vicinity of said at least one organic molecule.
2. A device according to claim 1 wherein the at least one organic molecule provides at least one analyte receptor site.
3. A device according to any preceding claim wherein at least one analyte receptor site is located adjacent, but is not attached to, said at least one organic molecule.
4. A device according to any preceding claim wherein said at least one organic molecule is an elongated conjugated organic molecule having first and second ends, the first end being attached to the source electrode and the second end being attached to the drain electrode.
5. A device according to any preceding claim wherein a single organic molecule is attached to the source electrode and the drain electrode.
6. A device according to any preceding claim wherein said at least one organic molecule is attached to the source and drain electrodes via tunnel barriers.
7. A device according to claim 6 wherein the tunnel barriers are provided by electrically insulating regions of said at least one organic molecule.
8. A device according to claim 6 wherein the source and drain electrodes each comprise an insulating material that forms said tunnel barriers.

9. A device according to any preceding claim and further comprising a gate electrode.
10. A device according to any preceding claim in which a first layer of material provides the source electrode and a second layer of material provides the drain electrode wherein said first and second layers sandwich, and are spaced apart by, a third layer of substantially insulating material.
11. A device according to claim 10 wherein a recess is provided in the third layer of substantially insulating material to provide a region between the source and drain electrodes in which the at least one organic molecule is located.
12. A device according to any one of claims 10 to 11 wherein the thickness of the third layer of substantially insulating material is substantially equal to the length of the at least one organic molecule.
13. A device according to any one of claims 10 to 12 wherein at least one of the first and second layers of material comprise semiconductor material.
14. A device according to claim 13 wherein the semiconductor material comprises silicon.
15. A device according to claim 14 wherein the at least one organic molecule comprises end chains that will bind to silicon.
16. A device according to any one of claim 10 to 15 wherein the first layer of material comprises a silicon wafer, the second layer of material comprises polysilicon and the third layer of substantially insulating material comprises a silicon oxide.
17. A device according to claim 16 when directly or indirectly dependent on claim 10 wherein the wafer additionally carries a layer of polysilicon to form the gate electrode, the fourth layer being separated from the silicon wafer by a layer of silicon oxide.

18. A device according to any one of claims 16 to 17 that is formed using a process that comprises a complementary metal oxide semiconductor (CMOS) fabrication process.

19. A device according to any preceding claim and further comprising means for measuring the conductivity of the at least one organic molecule as a function of applied source-drain voltage.

20. A device according to any preceding claim when dependent directly or indirectly on claim 10 and further comprising means for measuring the conductivity of the at least one organic molecule as a function of applied gate voltage.

21. A device according to any one of claims 19 to 20 and further comprising integral electronic circuitry for measuring the conductivity of the at least one organic molecule.

22. A fluid analyser comprising an MSET device according to any preceding claim.

23. An analyser according to claim 22 and further comprising a pre-concentrator for releaseably retaining analytes from a fluid.

24. An analyser according to claim 23 wherein the pre-concentrator comprises a layer of material having a plurality of apertures through which a fluid can be passed, the internal surfaces of said apertures being adapted to releaseably retain analytes from the fluid.

25. An analyser according to claim 24 wherein the internal surfaces defining said plurality of apertures of the pre-concentrator are porosified.

26. An analyser according to any one of claims 24 to 25 wherein the layer of material from which the pre-concentrator is formed comprises a layer of silicon, said apertures being formed through said layer of silicon and arranged to form a honeycomb structure.

27. An analyser according to any one of claims 24 to 26 wherein the internal surfaces of the apertures of the pre-concentrator are reversibly adsorptive.
28. An analyser according to any one of claims 23 to 27 wherein the pre-concentrator comprises a heater.
29. An analyser according to any one of claims 23 to 28 and further comprising a fluid gating structure for controlling the flow of fluid from the pre-concentrator to the MSET device.
30. An analyser according to claim 29 wherein the fluid gating structure is arranged to selectively route fluid from the pre-concentrator to either one of the MSET device and an exhaust port.
31. An analyser according to claim 29 to 30 wherein the fluid gating structure comprises a substantially planar substrate and a shutter that is moveable in the plane of said substrate.
32. An analyser according to claim 31 wherein fluid is routed from the fluid gating structure to the MSET device along a channel having a long axis that is substantially perpendicular to the plane of the substantially planar substrate of the fluid gating structure.
33. An analyser according to claim 32 wherein the fluid gating structure comprises a shutter that is shaped such that it can engage and seal the entrance to said channel.
34. An analyser according to any one of claims 31 to 33 wherein the shutter may be retained, without the application of power, in an open position in which fluid is routed from the pre-concentrator to the MSET device or in a closed position in which fluid is routed from the pre-concentrator to an exhaust port.

35. An analyser according to any one of claims 31 to 34 wherein the shutter is a micro-electromechanical (MEMS) shutter.
36. An analyser according to claim 35 wherein the fluid gating structure comprises a MEMS electro-thermal actuation mechanism to impart movement to the MEMS shutter.
37. An analyser according to claim 36 wherein the fluid gating structure further comprises a MEMS compliant displacement mechanism.
38. An analyser according to any of claims 29 to 37 wherein the pre-concentrator, fluid gating device and MSET device are formed as substantially planar layers and are arranged in a stack.
39. An analyser according to claim 38 wherein each substantially planar layer comprises silicon.
40. An analyser according to any one of claims 22 to 39 and further comprising a fluid pump.
41. An analyser according to any one of claims 22 to 40 and further comprising an integral power source.
42. A method of chemical detection comprising the steps of; (a) taking a molecular single electron transistor comprising at least one organic molecule attached to a drain electrode and a source electrode wherein, in use, said at least one organic molecule provides a quantum confinement region and (b) providing at least one analyte receptor site in the vicinity of said at least one organic molecule for receiving analytes.
43. A method of chemical detection according to claim 42 and further comprising the step of (c) measuring the electrical characteristics of said molecular single electron transistor to determine the presence or otherwise of an analyte.

44. A method of chemical detection according to any one of claims 42 to 43 and further comprising the step of passing a fluid over the at least one analyte receptor site.

45. A carrier for a molecular single electron transistor device characterised by the carrier comprising a first layer of material to provide a source electrode and a second layer of material to provide a drain electrode wherein said first and second layers of material sandwich, and are spaced apart by, a third layer of substantially insulating material.

46. A carrier according to claim 45 arranged such that at least one organic molecule can be attached to the drain and source electrodes.

47. A carrier according to claim 46 wherein the source and drain electrodes are spaced apart by distance substantially equal to the length of the at least one organic molecule.

48. A molecular single electron transistor (MSET) detector device according to any one of claims 45 to 47 and further comprising at least one organic molecule attached to said source and drain electrodes wherein, in use, said at least one organic molecule provides a quantum confinement region.

49. A molecular single electron transistor (MSET) detector device comprising at least one organic molecule attached to a drain electrode and a source electrode wherein, in use, said at least one organic molecule provides a quantum confinement region characterised in that at least one of said source electrode and said drain electrode are formed from semiconductor material.

50. A method of forming a molecular single electron transistor comprising the steps of (i) forming source and drain electrodes and (ii) locating an organic molecule between said source and drain electrodes, characterised in that the source and drain electrodes are formed using a complementary metal oxide (CMOS) process.